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Interactive comment on "Round-robin evaluation of nadir ozone profile retrievals: methodology and application to MetOp-A GOME-2" _by_ A. Keppens et al.

Anonymous Referee #2

Received and published: 16 March 2015

The paper 'Round-robin evaluation of nadir ozone profile retrievals: methodology and application to MetOp-A GOME-2' by A. Keppens et al. describes a methodology to compare and validate the quality of two datasets and applies it to the round robin of two nadir ozone profile datasets from GOME-2 experiment. The described methodology includes: 1) satellite data collection, agreement in representation and settings, data content study for the satellite retrieval algorithms involved; 2) information content study of measurements of the two algorithms; 3) comparison with reference data (ozone sonde and lidars). The paper is well-written, even if in some cases the reported details make the reading difficult (see detailed comments below). On the contrary,

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some further details in the information content study would help the interpretation of some results (see detailed comments below). The content of this paper fits well within the scope of the AMT journal and it can be published on AMT after some revisions and clarifications .

Specific comments:

1) Cost function. In Line 4 of pag 11485 it is written that the optimal estimation approach searches for the minimum of a cost function of the form |y-F'(x)|. Actually the cost function of the Optimal estimation includes the constraint of the a priori!

2) Filtering of profiles. From Sect.s 4.2 and 4.3 I understand that RAL and OPERA applies their own filtering to GOME-2 data, resulting in different but comparable number of considered profiles. Then in the forth line of the Conclusions it is written that 'exactly the same level-1 radiance measurements' are used by the two algorithms. This is a bit confusing and a clarification is needed.

3) MQQ in Sect 5. MQQ is inserted in the list of the quality indicators of the retrieval that can be derived from the AKM. Actually also the Covariance Matrix is needed for its computation.

4) Computation of MQQ and DFS in Sect. 5.1. The two main quantifiers chosen for studying the information content of the two datasets are the grid-normalised relative measurement quality quantifier MQQ (indicated as QR) and the number of degrees of freedom of the signal (DFS). In the cited paper Ceccherini et al., 2012, the MQQ is computed as the trace of the Fisher Matrix, while in this paper it is computed as the trace of the 'fractional' Fisher matrix FR=SR-1AR computed with the fractional AR and SR. It is not immediate to see that these two approaches are equivalent. If you don't want to report the demonstration of that, it could at least be written that it can be demonstrated that the grid-normalised relative measurement quality quantifier QR computed using either F or FR and the DOF computed using either A or AR are the same.

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5) Signal information load in Sect. 5.1. It has to be defined or reference to it has to be provided.

6) Vertical density distribution of information would be useful. In Fig.4 it is reported the dependence on latitude and time of QR (MQQ) for OPERA and RAL, as well as their number of degrees of freedom. As written in the text, these two quantities provide complementary information, the former providing an assessment of the information contained in the measurement only, independently on the applied constraints, the latter providing information on the number of independent components of the unknown profile, depending also on the constraints used in the retrieval such as the retrieval grid and the constraints used in the cost function. Only the vertically integrated quantifiers (third row of Table 3) are provided in Fig. 4, while details on the information vertical distribution contained in the measurements, given by their density distribution (described in the second row of Table 3), would be very useful to understand the information provided by the two algorithms at the different altitudes. An example of this kind of analysis can be found in the paper [S. Ceccherini, B.Carli, P. Raspollini, 'Quality of MIPAS operational products', Journal of Quantitative Spectroscopy and Radiative Transfer, 45-55, 2013]. It has to be noted that while the information on which altitudes mostly contribute to the DFS is indirectly provided by the dependence on altitude of the vertical resolution (in Fig. 6), details on the information distribution contained in the measurements, independently on the applied constraints, would help in evaluating the complementary behaviour of RAL and OPERA algorithms as emerging from the values of QR reported in the lowest plots of Fig. 4.It is true that part of the information on this can be deduced from the median sensitivity profiles reported in Fig. 5. However, as it is written in the text, contrary to the MQQ, the vertical sensitivity depends on both the information contained in the measurements and on the applied a priori constraint. In general, if the a priori constraint is larger than needed, you can have a small sensitivity even if enough information is contained in the measurements. This is not the case for MQQ.

7) Vertical sensitivity in Sect. 5.2. The definition of the vertical sensitivity can be guessed from the text, but it is not clearly stated. I guess that it is the area of the fractional AKM row, that is written to be a unit-normalised measure for how sensitive the retrieval at a certain height is to all heights. What is it meant with unit-normalised? It seems in contradiction with the obtained values of 2.

8) Sect. 6.4 In order to make the reading more focused, many details reported in this section could be skipped or moved in the appendix.

9) Bias compared with random errors. In various parts of Sect. 7.1 (line 17 di pag. 11516, line 10 of pag. 11517and line 23 of pag. 11519) bias of the measurements is compared with the single measurement satellite random uncertainty. Furthermore it is also written that 'to be fully statistical significant the bias should exceed the combined satellite-ground random uncertainty'. This sentence is not true: the significance of the bias is determined by the fact that it is different of 0 within the error of the bias. It is true that when a single measurement is considered, if the bias is smaller than the random error, the retrieval error is mainly given by the random error. However, we have to consider that, while the bias remains constant when different measurements are averaged, the random error reduces with the square root of the number of averaged profiles. The bias should be compared with the error of the bias (given by the spread divided by the square root of the number of averaged profiles) to be understood if it is statistically significant and text and figure should be changed accordingly.

10) Fig A1 and Fig. 8. They are not legible, if not expanded up to at least 220%. Fig. A1 could be simplified, reporting only the elements that are discussed in the paper. Fig. 8 must be enlarged.

11) General comment. In general RAL and OPERA measurements present many complementaries. It would be interesting to understand how this complementary could be exploited to improve the quality of Ozone profiles.

Technical correction

1) Line 2 of pag. 11525: 'as shown in in the second column'. Please remove one 'in'.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 11481, 2014.

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